

Page 6, lines 18-30Making lugs with a captured silicone mold: FIG. 6

In one version of the process, shown in FIG. 6, the mold is a captured-silicon-silicone mold 603. A side view 604 and a top view 602 show a frame 201 with molds attached to each of the main joint areas; detailed view 606 shows a detail of mold 603 for the head lug 117. At 611 is shown the top tube, at 609 the down tube, and at 613 the header tube. Prior to being attached to frame 201, mold 603 is lined with silicone 607; during the curing process, silicon-silicone 607 expands to force the carbon fiber and epoxy that form the lay-up against the tubes. For this process, the details for curing the lugs are as follows: a ramp rate of 4 degrees a minute, an optimum temperature of 250 degrees, which is held for one hour, and a cooling period of 2 hours. In a refinement employed in the preferred embodiment, mold 603 is made so that as the end of the lug is approached, the lug tapers down to the tub. The taper improves the appearance of the lug and improves the distribution of stress along the tubes joined by the lugs and may also improve the riding qualities of the frame. A mold with this refinement is shown at 801 in FIG. 8.

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A disadvantage of making lugs with a captured ~~silicon~~silicone mold is that the surface which forms the exterior of the lug is ~~silicon~~silicone layer 607. ~~Silicon~~Silicone layer 607 is soft and adapts itself to irregularities in the surface of the lug lay-up. For example, if the last layer of the lay-up is cloth, the surface of the lug will retain the pattern of the fibers in the cloth. Extensive sanding is then required to obtain a smooth surface on the lug.

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This problem is avoided by the technique shown in FIG. 7. Again, three views are shown: a side view of the frame with the molds attached, a top view of the frame, and a detail 705 of the joint and the mold for head lug 117. Only one side of seat tube 717 and head tube 713 are shown in detail 705. As shown there, the lug is made up of 6 layers of carbon-fiber cloth. An inner layer 711, 719 of four layers of fabric is laid down around seat tube 717 and head tube 713, with layer 719 being cut long to cover the seam between layer 719 and layer 711, then expanding syntactic foam 715 is placed in the crotches of the tubes, and finally an outer layer 709 of two more layers of fabric is laid down. Then aluminum mold 707 is placed around the lug and the lug is cured. During the curing process, expanding syntactic foam 715 expands and forces outer layer 709 against the surface of mold 707 and inner layer 711 against the tubes. Because the impregnated outer layer is forced against the hard smooth surface of mold 707, instead of against a soft layer of silicon, the surface of the finished lug is smooth and far less sanding is required. Other advantages of this technique are that it permits the lugs to have extensive fairings, which strengthens the joint and that more pressure is generated than with a captured silieon-silicone mold. The syntactic foam may of course also be used with a captured silieon-silicone mold. The curing parameters for this technique are as follows:

1. Heated at a ramp rate of 4 degrees Fahrenheit per minute to 250F
2. Cured at 250F for 1.5 hours.
3. Cooled for 2 hours